SOME OBSERVATIONS ON THE FORAGING BEHAVIOUR OF *FORMICA FUSCA* LINNÉ, AND SUCCESSFUL DEFENCE AGAINST *FORMICA SANGUINEA* LATREILLE (HYM.)

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THESE notes are based on observations of two colonies of *Formica fusca* in the author's garden from 1979 - 1988. Both colonies are quite large, each with at least several hundred workers. They are of local origin and, therefore, have no previous experience of *Formica sanguinea,* which does not occur in East Anglia.

Formica sanguinea was introduced in 1984. Other species present include several *Myrmica* spp, *Leptothorax acervorum, L. interruptus, Tetramorium caespitum, Tapinoma erraticum,* and *Lasius niger.*

General foraging behaviour of *Formica fusca*

Formica fusca is a widespread and often abundant species, and this, combined with its fairly large size, has long made it a convenient ant for study. It is alert and fast-moving, with considerable individual initiative. It usually forages singly, taking a wide variety of prey and carrion. It will sometimes tend aphids, but also milks less strongly guarded herds belonging to other species, such as *Lasius niger,* using its agility to avoid capture.

Territorial knowledge

In addition to being an alert forager, this species appears to have a detailed knowledge of even sporadic food sources within its foraging range. This has been noticed because of its conspicuous ability quickly to find food put down for the other species mentioned above. In fact, most movable prey items are taken by this species even when they have been placed very near the nest entrances of the other species.

It is quite likely that individual *fusca* workers have favoured foraging areas, but the author lacks the marking system necessary to prove this.

Stealing food

F. fusca is not an aggressive ant, but it will steal food that has been found by another species if it can surprise them. With small species (even *Tapinoma*) it will cautiously approach and reach over the other ants with its antennae to examine the prey. If not too large it will retreat slightly, then dart forward and snatch the prey and run off, usually scattering the smaller ants in the process. However, it is less likely to try to steal prey that is being moved by another ant. It rarely, if ever, steals brood from workers of a colony that is moving to a new nest site — not even small *Leptothorax* species.

It is often very persistent and, if disturbed while trying to move or steal prey, it will circle and return repeatedly, the radius of the circle usually increasing slightly each time.

This cautious approach is in clear contrast to the aggressive behaviour of *F. sanguinea*. When *Lasius niger* pupae and workers were placed about one foot from the *sanguinea* nest the ever-present *fusca* rapidly started stealing the pupae, skilfully evading the *niger* workers. The *sanguinea,* however, gathered by the nest, and carefully advanced on the *niger*. They took few brood until the *niger* workers had been driven off or killed, showing their need to dominate the area. This took about ten minutes, by which time *fusca* had stolen at least twenty pupae.

Selectivity towards prey

During July and August 1988 the author conducted some observations to see if *F. fusca* workers are selective when given a choice of prey. This involved closely watching the behaviour of workers finding *Lasius niger* male, female and worker pupae placed by a *Tetramorium* colony, about five feet from the *fusca* nest, across rough terrain.

It was hoped that the *fusca* would show some preference for a particular size. This selectivity might be affected by the increasing presence of *Tetramorium* workers, either hurrying the *fusca* into taking the nearest or smaller pupae, or possibly even increasing the tendency to take larger pupae before they lose the opportunity.

Unfortunately, the results were not completely conclusive. The first workers to find the pile of pupae would usually walk over it for a while (evaluating it?) before taking one, quite often a male or female pupa. Sometimes they would pick up a worker pupa, then put it down again. Not surprisingly, large workers tended to take larger pupae. Smaller workers often gave up trying to move female pupae. However, individuals varied considerably. The presence of *Tetramorium* workers did seem to have some effect in reducing the size of pupae taken.

Transport of prey

Small prey items are usually carried to the nest without stopping, as would be expected. Larger pieces are usually dragged, although they may be carried in front when going downhill. Often, workers proceeded by dragging the prey briefly, swinging it round in front then dragging it again and so on.

Most species behave similarly. When dealing with very large, awkwardly shaped loads, ants often stop to change their grip. Interestingly, *fusca* sometimes leaves such prey and explores a short distance ahead, giving the distinct impression of trying to find the easiest way ahead. *F. sanguinea* may behave similarly.

Both species also stop and circle their load briefly. As a result they sometimes lose it, and may take several minutes to find it again. Apart from giving a rest, this circling may have a defensive function. On several occasions the author has seen spiders of the genus *Xysticus* slowly following *fusca* workers carrying female *Lasius* pupae. No spider has yet been observed to catch up, but the spider is likely to steal the pupa. These spiders are undoubtedly capable of taking worker ants by ambushing them in vegetation, but on two or three occasions the author has also seen *Tetramorium* and *Leptothorax interruptus* workers attempting to catch smaller specimens of the same spider. The spiders are probably reluctant to attack an ant in the open, so, by briefly circling its load, the ant may well reduce the risk of being surprised by predators.

Recruitment

The second aim of the experiment described above was to see if the *fusca* recruited other workers to help collect the *Lasius* pupae.

Possible methods of recruitment are:—

(a) Chemical attractants.
(b) Chemical trails which also stimulate workers to follow them.
(c) Chemical trails which do not stimulate workers to follow them.
(d) "Language".
(e) No recruitment, relying on workers to find the prey independently.

The pupae were often found by two foragers independently within five minutes or so of each other. These would continuously shuttle back and forth to the nest, but spent very little time there. A third ant did not usually join in for some time, often 30 minutes or more, but from then on others usually joined in about every five to ten minutes, to a maximum of five to eight workers. Ants finding the pupae independently usually used different routes to the nest, and rarely changed route. It was not clear how precisely ants followed the same route on each occasion, which would help decide if a trail was laid.

According to Möglich and Hölldobler (1975) *F. fusca* does, in fact, lay trails to food sources, but they act only as an aid to orientation, and do not stimulate nest mates (possibility (c)). Stimulation is apparently achieved by a rocking behaviour (d) of the forager and passing of food from its crop on arrival at the nest.

The above observations did not contradict this but, if they are correct, the method is rather inefficient. Possibilities (c) and (d) would both be very difficult to verify in the field; (b) can almost certainly be ruled out, and (a) appears to make little or no contribution in these circumstances; (e) is significant at first, accounting for up to two or three workers.

Colony moving

This is really a special case of recruitment. Interestingly, workers commonly carry each other to a new nest but apparently not to food.

The author has only once witnessed this species move to a new site. The initial scouting and recruitment was done by a single worker, recognisable by a dent in its abdominal armour. The fact that a fairly small number of workers move a colony is also true for *F. sanguinea.* Presumably some workers may learn the route as they are carried, as has been shown for *Rossomyrmex proformicarum,* which recruits for slave raids in this way (Marikovsky, 1974).

Marriage flights

It is well known that *Formica* species usually do not have the massive marriage flights of *Lasius.* Instead, the alates wander about and the females, in particular, often do not fly, probably attracting the males with pheromones. *F. fusca* is no exception, and alates typically appear on fine mornings in July and August, although the author has seen them as early as the beginning of April, and as late as mid-October. These are certainly overwintered, especially in windy coastal areas. As the alates often stay fairly near the nests (less than ten feet) they can return if they do not find mates. This is less wasteful than the *Lasius* method, but dispersal may not be so effective. *L. alienus* is known to kill alates that have not flown (Jensen and Nielsen, 1975).

Raiding tactics of *Formica sanguinea*

Over the last hundred and fifty years or so much has been written about the slave-making raids of *F. sanguinea* and *Polyergus* species. This account will mainly be concerned with the factors influencing the success of a raid. The account by Huber, quoted in Donisthorpe (1927) most agrees with the author's observations.

When foraging, *F. sanguinea* will chase other ants in a similar manner to other aggressive species, such as *F. rufa.* However, while the latter uses identical tactics in large scale attacks, *sanguinea* does not. It is well-known for avoiding "in-fighting", especially in the early stages of an attack. This becomes increasingly evident when fighting large species. It aims to dominate an area, driving off the opposition, preferably without physical combat. Raids usually take place on warm days in July.

The main stages of a typical raid are:—

(1) Preliminary activity by the *sanguinea* nest, and scouts dispatched.

(2) Advance of more workers, more cautiously near the *fusca* nest.

(3) Build up in numbers of *sanguinea* near the *fusca* nest, while advancing slowly. A trail may be laid back to the *sanguinea* nest, as has been shown for *Polyergus lucidus* (Marlin, 1969).

(4) Final assault — not witnessed by the author. Other accounts state that the *fusca* nest is often blockaded at the same time.

Stage (3) seems to be the key to success. The *sanguinea* workers do not charge forward as they get close to the *fusca* nest, but move carefully in a roughly circular manner, advancing a few inches, then turning, often stopping to greet the workers following. These meetings are probably of vital importance to the advance, as they appear to lead to an awareness of support which, if removed, leads to a retreat. The leading ants change constantly. At this stage reinforcements should be arriving frequently. It is vital that the *sanguinea* numbers build up quite quickly. Most fights are started by *fusca* and, although *sanguinea* workers are stronger than those of *fusca,* they can safely cope with only one undamaged *fusca* at a time. Therefore it is essential that there remains a *local excess* of *sanguinea* so the forward momentum can be maintained. This gives those workers temporarily immobilised by *fusca* time to kill their opponent without risk of being attacked by a second one. *F. sanguinea* relies much more on mandible contact than does *F. rufa* because poisons are too slow-acting. As a result it carries less acid, so slightly improving mobility. The importance of continually moving forward probably also explains why, when raiding, *sanguinea* tends not to help comrades that have been attacked, in contrast to when they are foraging. (The whole episode is, in effect, more like a rugby match than a medieval battle.)

Defensive response of *F. fusca*

F. fusca has often been described as a cowardly species, but cautious would be more accurate. It certainly prefers to avoid trouble and, except for *fusca* from a hostile colony, it very rarely attacks other ants. However, it will often fight fiercely in defence of its nest, if its chances of success are reasonable. This has been emphasised by the repulsion of several *sanguinea* attacks by the two colonies in the author's garden, including one in July 1988 involving 150-200 *sanguinea* workers. It shows that, while *fusca* is instinctively hostile to *sanguinea,* the reported tendency to flee from an attack is learned, as rapid flight is probably a sensible tactic to persistent attacks from large *sanguinea* colonies. Small *sanguinea* colonies probably rely on finding nervous, weakened *fusca* nests to attack.

The key to a successful defence is the alert nature of this species, and the very rapid response to an impending attack. Until 1988 *sanguinea* had always attacked the nearer of the two *fusca* colonies, and *fusca* foraging near the *sanguinea* nest would often wander around it, stopping occasionally, giving a definite impression of watching it.

Experiments are needed to ascertain whether *fusca* does, in fact, anticipate *sanguinea* raids. This might occur by two methods:—

(i) Detection of external changes or behaviour of the *sanguinea* (most likely chemical) as the raiding season approaches.

(ii) Knowledge by experience that raids occur at a particular time. This would be very significant, as it implies a long-term memory.

These *fusca* will not tolerate *sanguinea* workers within three or four feet of their nest. When a scout (stage one) is located, the *fusca* worker attacks it. If it misses it runs rapidly in circles. Alarm pheromones are undoubtedly released. Nearby workers start to search, and almost immediately others will be attracted from the nest, until, if several *sanguinea* are caught, several hundred *fusca* may be involved.

The whole body advances in a similar fashion to *sanguinea,* but faster. Solitary *sanguinea* are attacked immediately and are overwhelmed by up to about six *fusca* that are attracted to the spot. Groups of *sanguinea,* particularly if further from the *fusca* nest, *may* not be attacked immediately. *Fusca* tend not to stop and greet each other — being rather wary, they usually run from any fast approaching object — but either by an awareness of movement, or by chemical means, they appear to realise if they will have support.

Fusca workers attack *sanguinea* by racing in and seizing a leg or antenna. They are strong enough to restrain most *sanguinea* for at least five or ten minutes. If they manage to grip the base of a leg, the *sanguinea* will still be hindered even after the *fusca* has been killed.

The *fusca* have the advantage of being near their nest, so re-inforcements arrive quickly. In the raids the author has observed, *fusca* numbers built up rapidly enough to completely overrun the advancing *sanguinea,* forcing them to flee, either towards their nest, or up into vegetation where they are less likely to be found. The *fusca* pursued them all the way back to the nest and seized several workers just outside it, but never attempted to enter it.

For several days afterwards the *fusca* constantly maintained a stronger than usual presence on and around the *sanguinea* nest, and attacked any that ventured out. Later this was reduced, the *sanguinea* site being within the foraging range of the other *fusca* colony. Aggressive *fusca* workers occasionally attack *sanguinea* foragers but usually they soon let go, or are killed, and other *fusca* rarely go to their aid if the colony is not threatened, particularly if the fight is near the *sanguinea* nest.

References

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An early Hummingbird Hawkmoth in Kent.

About midday on 4th March 1990 I was surprised to see a Hummingbird Hawkmoth, *Macroglossum stellatarum* L. flying along the top of the cliffs at Foreness Point near Margate in Kent. It was under observation for some five minutes during which time it made a series of quick dashes followed by periods of hovering as though it was searching for flowers which were rather sparse at this early date.— ERIC G. PHILP, 6 Vicarage Close, Aylesford, Kent ME20 7BB.